

ANSWERS TO MULTIPLE CHOICE QUESTIONS

1. The net work done on the wheelbarrow is

$$\begin{aligned} W_{\text{net}} &= W_{\text{applied}} + W_{\text{friction}} = F \cos 0^\circ \Delta x + f \cos 180^\circ \Delta x \\ &= F - f \Delta x = 50.0 \text{ N} - 43 \text{ N} \cdot 5.0 \text{ m} = +35 \text{ J} \end{aligned}$$

so choice (c) is the correct answer.

2. In the absence of any air resistance, the work done by nonconservative forces is zero. The work–energy theorem then states that $KE_f + PE_f = KE_i + PE_i$, which becomes

$$\frac{1}{2} m v_f^2 + m g y_f = \frac{1}{2} m v_i^2 + m g y_i \quad \text{or} \quad v_f = \sqrt{v_i^2 + 2g(y_i - y_f)}$$

Choosing the initial point to be where the skier leaves end of the jump and the final point where he reaches maximum height, this yields

$$v_f = \sqrt{15.0 \text{ m/s}^2 + 2 \cdot 9.80 \text{ m/s}^2 \cdot 4.50 \text{ m}} = 11.7 \text{ m/s}$$

making (a) the correct answer.

3. The mass of the crate is

$$m = w/g = 40.0 \text{ N} / 9.80 \text{ m/s}^2 = 4.08 \text{ kg}$$

and we may write the work–energy theorem as

$$W_{\text{net}} = W_{\text{fric}} + W_{\text{grav}} = KE_f - KE_i$$

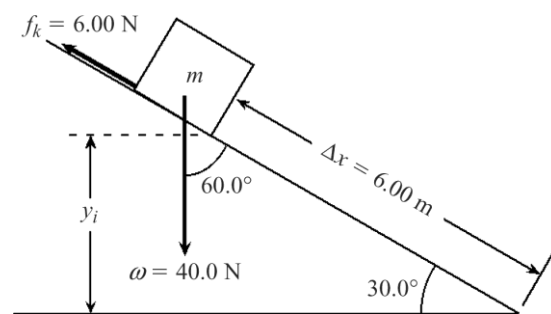
Since the crate starts from rest, $KE_i = \frac{1}{2} m v_i^2 = 0$,

and we are left with

$$KE_f = W_{\text{fric}} + W_{\text{grav}} = f_k \cos 180^\circ \Delta x + w \cos 60.0^\circ \Delta x$$

so

$$KE_f = -6.00 \text{ N} \cdot 6.00 \text{ m} + 40.0 \text{ N} \cos 60.0^\circ \cdot 6.00 \text{ m} = -36.0 \text{ J} + 120 \text{ J} = 84.0 \text{ J}$$



and

$$v_f = \sqrt{\frac{2KE_f}{m}} = \sqrt{\frac{2 \cdot 84.0 \text{ J}}{4.08 \text{ kg}}} = 6.42 \text{ m/s}$$

making choice (d) the correct response.

4. We assume the climber has negligible speed at both the beginning and the end of the climb. Then $KE_f = KE_i \approx 0$, and the work done by the muscles is

$$W_{nc} = 0 + PE_f - PE_i = mg y_f - y_i = 70.0 \text{ kg} \cdot 9.80 \text{ m/s}^2 \cdot 325 \text{ m} = 2.23 \times 10^5 \text{ J}$$

The average power delivered is

$$\overline{P} = \frac{W_{nc}}{\Delta t} = \frac{2.23 \times 10^5 \text{ J}}{95.0 \text{ min} \cdot 60 \text{ s/1 min}} = 39.1 \text{ W}$$

and the correct answer is choice (a).

5. The net work needed to accelerate the object from $v = 0$ to v is

$$W_1 = KE_f - KE_i = \frac{1}{2}mv^2 - \frac{1}{2}m \cdot 0^2 = \frac{1}{2}mv^2$$

The work required to accelerate the object from speed v to speed $2v$ is

$$W_2 = KE_f - KE_i = \frac{1}{2}m \cdot (2v)^2 - \frac{1}{2}mv^2 = \frac{1}{2}m \cdot 4v^2 - \frac{1}{2}mv^2 = 3 \cdot \frac{1}{2}mv^2 = 3W_1$$

Thus, the correct choice is (c).

6. Assuming that the cabinet has negligible speed during the operation, all of the work Alex does is used increasing the gravitational potential energy of the cabinet. However, in addition to increasing the gravitational potential energy of the cabinet by the same amount as Alex did, John must do work overcoming the friction between the cabinet and ramp. This means that the total work done by John is greater than that done by Alex and the correct answer is (c).
7. Since the rollers on the ramp used by David were frictionless, he did not do any work overcoming nonconservative forces as he slid the block up the ramp. Neglecting any change in kinetic energy of the block (either because the speed was constant or was essentially zero during the lifting process), the work

done by either Mark and David equals the increase in the gravitational potential energy of the block as it is lifted from the ground to the truck bed. Because they lift identical blocks through the same vertical distance, they do equal amounts of work and the correct choice is (b).

8. Once the athlete leaves the surface of the trampoline, only a conservative force (her weight) acts on her. Therefore, her total mechanical energy is constant during her flight, or $KE_f + PE_f = KE_i + PE_i$. Taking the $y = 0$ at the surface of the trampoline, $PE_i = mgy_i = 0$. Also, her speed when she reaches maximum height is zero, or $KE_f = 0$. This leaves us with $PE_f = KE_i$, or $mgy_{\max} = \frac{1}{2}mv_i^2$, which gives the maximum height as

$$y_{\max} = \frac{v_i^2}{2g} = \frac{8.5 \text{ m/s}^2}{2 \cdot 9.80 \text{ m/s}^2} = 3.7 \text{ m}$$

making (c) the correct choice.

9. $KE_{\text{car}} = \frac{1}{2}m_{\text{car}}v^2 = \frac{1}{2}m_{\text{truck}}/2v^2 = \frac{1}{2} \cdot \frac{1}{2}m_{\text{truck}}v^2 = KE_{\text{truck}}/2$, so (b) is the correct answer.

10. The kinetic energy is proportional to the square of the speed of the particle. Thus, doubling the speed will increase the kinetic energy by a factor of 4. This is seen from

$$KE_f = \frac{1}{2}mv_f^2 = \frac{1}{2}m(2v_i)^2 = 4\left(\frac{1}{2}mv_i^2\right) = 4KE_i$$

and (a) is the correct response here.

11. The work–energy theorem states that $W_{\text{net}} = KE_f - KE_i$. Thus, if $W_{\text{net}} = 0$, then $KE_f = KE_i$ or $\frac{1}{2}mv_f^2 = \frac{1}{2}mv_i^2$, which leads to the conclusion that the speed is unchanged $v_f = v_i$. The velocity of the particle involves both magnitude (speed) and direction. The work–energy theorem shows that the magnitude or speed is unchanged when $W_{\text{net}} = 0$, but makes no statement about the direction of the velocity. Therefore, choice (d) is correct but choice (c) is not necessarily true.

12. As the block falls freely, only the conservative gravitational force acts on it. Therefore, mechanical energy is conserved, or, $KE_f + PE_f = KE_i + PE_i$. Assuming that the block is released from rest ($KE_i = 0$), and taking $y = 0$ at ground level ($PE_f = 0$), we have that

$$KE_f = PE_i \quad \text{or} \quad \frac{1}{2}mv_f^2 = mgy_i \quad \text{and} \quad y_i = \frac{v_f^2}{2g}$$

Thus, to double the final speed, it is necessary to increase the initial height by a factor of four, or the correct choice for this question is (e).

- 13.** If the car is to have uniform acceleration, a constant net force F must act on it. Since the instantaneous power delivered to the car is $\mathcal{P} = Fv$, we see that maximum power is required just as the car reaches its maximum speed. The correct answer is (b).